U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 193.

Experiment Station Work,

XXV.

Compiled from the Publications of the Agricultural Experiment Stations.

WATERMELONS IN THE NORTH.
WATERMELON CULTURE IN GEORGIA.
MUSKMELON CULTURE IN THE NORTH.
ROCKYFORD MUSKMELONS.
COLD STORAGE OF FRUITS.
SELECTION OF SEED CORN.
BREAD AND TOAST.
COOKING MEAT.
BITTER MILK.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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ILLUSTRATIONS.

EXPERIMENT STATION WORK.[a]

WATERMELONS IN THE NORTH.[b]

The natural home of the watermelon is in the South. There it reaches its greatest perfection. The States of largest production are Georgia, Texas, and Missouri, in the order named; but large quantities are grown in every Southern State. The number of melons shipped yearly from those States to northern markets runs up into the millions. The watermelon is universally esteemed. While it does not grow so luxuriantly in the North, nevertheless the watermelon "patch" is a feature of many northern farms. The melons grown, while often of good quality, are usually medium sized and less marketable than melons grown in the South. Prof. F. W. Rane believes that the great drawback to the more successful culture of watermelons in the North is a lack of knowledge of the best methods of growing them. His experiments lead him to believe that with a better selection of soils and more pains taken in the preparation of the hills, a surprisingly large percentage of even southern varieties of watermelons could be made to mature as far North at least as southern New Hampshire.

In a bulletin from the New Hampshire Station, Professor Rane gives in detail the methods there observed in growing melons for market. From this account it appears that "while watermelons may be grown on almost any soil, excepting, perhaps, a heavy clay, they thrive best on a rich, warm, sandy loam that is well supplied with humus. A southern slope is preferable, although not necessary for success, as it hastens maturity and furnishes early natural drainage, which is very essential, especially in a cold and wet season."

The watermelon is sensitive to frost and easily stunted in growth by cold. The best date for planting in southern New Hampshire has been found to be between May 20 and 31. In the station experiment the field used was an old sandy-loam pasture. This was heavily manured in the fall with strawy stable manure, which was plowed under. The following April the field was again plowed and then cultivated weekly until May 22, when the seeds were planted. The

[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from New Hampshire Sta. Bul. 86.

object of the spring cultivation was to destroy weed seeds and to put the ground in a light friable condition. This preparation is believed to induce a good development of runners and feeders which are necessary for success.

The hills are planted 10 feet apart each way. They are dug 8 to 10 inches deep, 18 to 24 inches in diameter, and filled two-thirds full with rich, well-rotted manure. A good stable manure that has been piled up over winter and thoroughly chopped over is preferred. To this is added a small quantity of hen manure and sand.

Enough soil is drawn on this and thoroughly mixed with the compost to fill the hill nearly full. A half pint of unleached wood ashes or fine hen manure or a small handful of phosphates is sprinkled over the top soil and well mixed with it, after which enough soil is added to make the hill level with the top of the ground. The hill is now ready for the seed. The seed should be from a reliable source. Ten or twelve seeds should be planted in a circle, about 1 foot in diameter, in the center of each hill; then draw on from one-half to two-thirds of an inch of fresh, moist soil, and press it down firmly with the hoe; also, add lightly from one-fourth to one-half inch of loose dirt, to act as a mulch. When the seeds germinate, and as soon as the plants begin to run or after all danger from insects is past, thin to two or three plants, leaving the thriftiest in each hill.

Cultivation is begun as soon as the plants are well up. It is made deep and thorough and as often as necessary to keep down the weeds. Especial pains are taken to loosen the soil about the plants after rains. When the vines begin to run more shallow cultivation is practiced. The vines at this time are very tender, and great care is taken not to step on them or injure them in any way. Should strong winds prevail and the vines be blown about, a little loose dirt is drawn over them at intervals of 3 or 4 feet. This serves to hold them in place until the melons get large enough to hold them.

Should the small striped cucumber beetles appear about the time the plants come up, they may be driven away by lightly sprinkling the plants with some such substance as tobacco dust, ashes, ground bone, plaster, or lime. The beetles are likely to appear suddenly, and if not taken in hand at once may destroy the entire field.

In New England the melons begin to ripen in August and continue in bearing until killed by the first frosts.

The quality of the watermelon is finer if gathered in the morning when cool; the fruit will also keep in better condition. Melons picked at the proper time, carefully handled, and stored in a cool cellar will keep from four to six weeks.

The best melon for home use or the general retail trade in New Hampshire is a medium-sized variety with a thin rind, red flesh, early, and extra sweet, weighing from 12 to 25 pounds. Market gardeners who have not attempted growing this crop can little realize what can be accomplished in the way of building up a good trade with this fruit. The home-grown melon, fresh from the field, will recommend itself. * * * The markets are very good, and the fruits sell readily at from 1 to 2 cents a pound. * * *

The varieties thought to possess special merit for the North, named in so far as possible in order of merit, are Cole Early, Boss, Black Eyed Susan, Peerless, Kleckley Sweet, Black Boulder, Black Spanish, Phinney Early, Frontenac, Hungarian Honey.

The first three of these are especially recommended by Professor Rane for garden culture in New Hampshire (fig. 1). Cole Early produces a round or slightly oval, medium-sized fruit, having irregular stripes of light and dark green; the flesh is red, solid, and very sweet; the rind brittle, and the seeds dark brown. It is an early and reliable variety in New England. Boss produces a long, dark-green melon

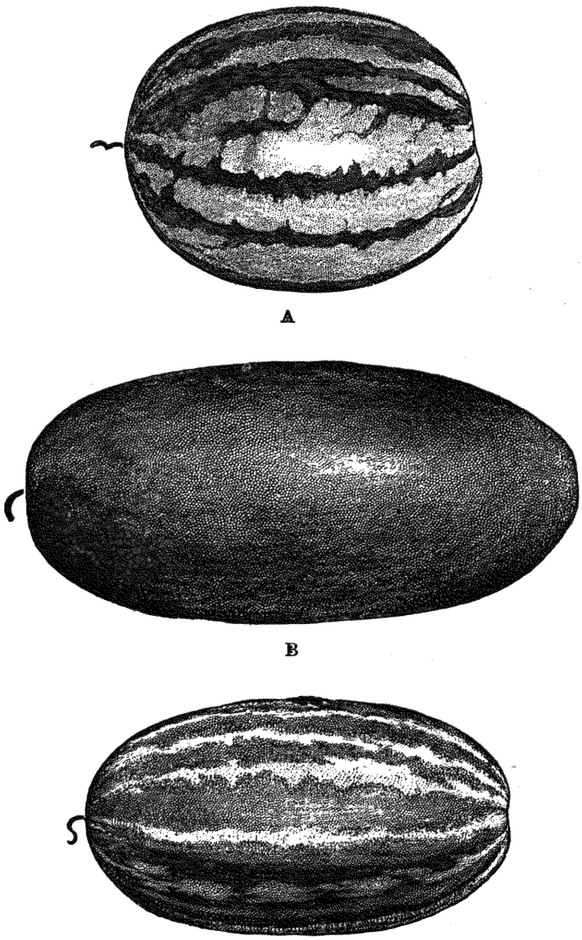

FIG. 1.—Some varieties of watermelons recommended for northern culture: A, Cole Early; B, Boss; C, Black Eyed Susan.

which is very heavy for its size; the flesh is solid, red, and of the best quality; the seeds are black. Black Eyed Susan is a southern variety which promises well for northern culture. The fruit is oblong to long, with light stripings; the rind is thin and tough; the flesh scarlet colored, firm, and of extra quality; the seeds white, with dark spots at the sprout end. It is an early variety.

WATERMELON CULTURE IN GEORGIA.[a]

As already stated, the watermelon thrives best in the South, and no part of the South, says Professor Starnes, of the Georgia Station, seems more peculiarly suited to it than that part of Georgia covered by the yellow-pine forests and known locally as the "wire-grass region." This region abounds in the warm, light, well-drained sandy loams so well adapted to watermelon culture. Professor Starnes gives the following instructions for the culture of watermelons in Georgia for the use especially of small growers:

Preparation of the soil should be thorough, but not necessarily deep, as the roots of the melon are surface feeders. Complete pulverization is necessary. One breaking and two effective harrowings, with a "cutaway" or even a "smoothing" harrow, generally prove sufficient. It is always desirable that a crop of cowpeas should precede melons. Under no circumstances should melons follow melons, and at least four seasons should intervene before the land is again devoted to this crop.

The richer the soil the greater should be the distance apart of the hills; 12 by 12 feet, 12 by 10 feet, or 10 by 10 feet are the usual distances employed.

Fertilizer should be applied in the drill and bedded on, not concentrated in the hill. Aside from stable manure, the best (commercial) fertilizer is a compound of 400 pounds nitrate of soda, 800 pounds acid phosphate, and 200 pounds muriate (or sulphate) of potash. Use at the rate of 700 pounds and upward per acre. An extra pinch of nitrate of soda to each hill, just after the plants have appeared, will give them a good "send off."

The varieties recommended are, (1) for shipping, Lord Bacon first choice, followed by Kolb Gem and Augusta Rattlesnake (fig. 2); (2) for family use, Seminole, Sibley Triumph, Jordan Gray Monarch, and Ramsay; (3) for early melons, Memphis, Augusta Sugarloaf, and Augusta Rattlesnake; (4) for late melons, Boss, Scalybark, and Sweetheart.

Planting should be done by hand and should be shallow. Plenty of seed should be used—20 to 30 to the hill—and each seed pushed down not deeper than an inch with the forefinger. A "hoe-dab" of moist dirt to the hill, after planting, knocked off before sprouting, will hasten germination in very dry weather.

After the plants are up they should be thinned down to three or four to the hill, and afterwards to one or, at most, two vines. Cultivation should be shallow, with cultivator or scrape. Vines should never be turned, nor should the crop be plowed during the early forenoon. When it becomes necessary to turn vines to get the plow through cultivation should cease. A thin broadcasting of cowpeas at

[a] Compiled from Georgia Sta. Bul. 38.

last cultivation is advisable to prevent winds from tumbling and rolling the vines.

Plantings for shipment should be directly on a line of railroad. The melons should always be hauled on springs to the car and severely culled. The profit depends absolutely on the proper selection for the market.

Early melons may be forced by starting under glass in paper (Neponset) pots and transplanting immediately after danger from frost is over. A section of 2-inch tile or sewer pipe, sunk perpendicularly into the hill, through which water or liquid manure is fed daily, will materially assist growth.

Melons may be had at Christmas by selecting a thick-rind variety, planting late in June, handling carefully when pulled, and storing on some dry, yielding substance, like cotton-seed hulls, in a cool cellar where the temperature is uniform and can never drop below freezing.

FIG. 2.—Some varieties of watermelons recommended for culture in Georgia: A, Rattlesnake; B, Kolb Gem.

Some of the choicest melons grown in the South are such poor shippers that they never reach the northern markets, and, in fact, never leave the farm. Thus Lord Bacon, Kolb Gem, and Augusta Rattlesnake, so largely grown for shipment, are distinctly inferior in quality to many other varieties, but they have tough, thick rinds, which enable them to reach market in better condition than the choicer thin-rind varieties. Professor Starnes thus describes some of the best southern varieties for shipping and for home use.

Lord Bacon.—Very large, round or slightly ovoid, with habit of resting on the blossom end; deep green, with faint light-green stripes; rind thick; seed white; flesh bright red, sweet and good, but slightly pithy; early, yet continues to bear well up to the close of the season, the vines possessing great vitality.

Kolb Gem.—Has long been the type of a perfect shipper; large, round; skin and color of Rattlesnake type; rind very thick and tough; melon firm and solid; seed black; flesh red, tough, stringy, and coarse, but well flavored and quite sweet; its quality distinctly good, though coarse; season early.

Augusta Rattlesnake.—Large, long, light green with dark-green longitudinal stripes; flesh red, crisp, tender; quality good; seed buff with dark-brown or black tips; rind thick; an excellent shipper; early.

Seminole.—A valuable melon for home use, but not a good shipper; very showy; size immense and extremely uniform; oblong, both ends same diameter; rind very thin; seed brown; flesh bright red, crisp, and of excellent quality; early.

Sibley Triumph.—Medium to large, long, light green with dark bands; rind thick; seed white; flesh a beautiful, deep red, sweet, luscious.

Jordan Gray Monarch.—Large, long, white, with light-green tracery; rind rather thin; seed brown; flesh bright crimson, crisp, firm, and sugary; a magnificent family melon; medium in season.

Ramsay.—Small, oblong; dark green with darker-green bands; rind very thin; seed white; flesh bright scarlet, sweet, sugary; an ideal family melon.

MUSKMELON CULTURE IN THE NORTH.[a]

Only about one-third as much land is devoted to muskmelon[b] culture in the United States as to watermelons, but the area devoted to it is rapidly increasing. Owing to its smaller growth it is more easily and successfully grown in northern localities than the watermelon. The States of largest production are widely scattered. New Jersey leads in acreage, followed by Texas, Illinois, Indiana, Maryland, Virginia, Arkansas, and Colorado. A number of the experiment stations have published bulletins dealing with the culture of muskmelons. Some of the different phases of culture treated in these bulletins, such as the manuring of muskmelons, transplanting, etc., and the culture of muskmelons under glass have been noted in previous bulle-

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[a] Compiled from New Hampshire Sta. Buls. 72, 99; New York Cornell Sta. Bul. 200.

[b] The term "muskmelon" is here used in a wide or generic sense, to include not only the furrowed, hard-rind melons known as "cantaloupes," but also the netted, softer-rind kinds known as "nutmeg" or "netted" melons. The term "cantaloupe" is thus confined to a particular class of muskmelons.

tins of this series.[a] In a bulletin of the New York Cornell Station, J. Craig gives an account of the methods followed by successful farmers in Niagara County, N. Y., in the culture of muskmelons.

Muskmelon growers in that county secure their early melons by starting the plants either in the hotbed or greenhouse late in April or early in May and transplanting to the open field when all danger from frost is past, usually during the third or fourth week in May. For this early crop the seeds are sown in bottomless boxes, like berry boxes, made for the purpose, and about 3 inches square and 4 inches deep. A wad of well-rotted barnyard manure is pressed in the bottom of these boxes, which are then filled with light garden loam well packed down. About five seeds are sown in each box. The seeds are covered by sifting soil over them and the usual attention given to watering and heat. The temperature of the plant house is kept at about 85° F. in the daytime and 60° to 70° at night. Should the "damping off" fungus threaten, it is kept in check by free ventilation, careful watering, keeping the heat up during cloudy periods, and by spraying the plants with a solution of potassium sulphid, using about 1 ounce of the sulphid dissolved in 3 gallons of water.

The soils most in use vary from light sandy loam to clay loams. The sandy loams produce early melons of good quality. Clover is quite generally used in the rotation to put the land in good condition. The melon crop may either follow the clover crop directly or a hoed crop which was preceded by clover sod. After plowing, which is usually done in the fall, except on the lightest lands, and thorough cultivation in spring, the ground is marked out in rows 6 feet apart each way and a forkful of barnyard manure or a handful of commercial fertilizer worked into the soil at the intersection of the rows. If plants are used, they are set in these prepared hills, the boxes being first removed and a cube of earth with the plants set in a hole made with the hand, the soil being firmly packed down around them. Transplanted melons usually produce the bulk of their crop somewhat in advance of field-sown crop, and the advantage obtained in price is usually more than enough to counterbalance the extra expense of growing the plants under glass and transplanting.

Melons for the late crop are almost entirely grown from seed planted where the crop is to mature. In field seeding 10 to 15 seeds are dropped in each hill, made in the same way as for the transplanted melons noted above, and lightly covered. After danger from insect and other pests is past all the plants are removed except four or five of the strongest.

Sometimes instead of planting the seeds in hills they are sown in rows 5 to 7 feet apart and the plants thinned to stand about 2 feet apart in the row. When thus planted commercial fertilizers may be sown along the rows with a drill at the time of seeding. The Arkan-

[a] U. S. Dept. Agr., Farmers' Buls. 119, p. 20; 124, p. 14; 133, p. 18; 149, p. 15.

sas Station[a] recommends spreading barnyard manure along the rows and thoroughly incorporating it in the soil by horse cultivation. This does away with the hand work of forking the manure into each separate hill and seems to give fully as good results.

The field culture of muskmelons is practically the same whether the plants are first started under shelter or whether the seeds are sown in the field direct, and consists of thorough shallow cultivation in the early part of the season before the vines become long enough to interfere with this work.

Writers on muskmelon culture have frequently recommended pinching or heading in the vines as a method of increasing the fruitfulness of the plants. The New Hampshire Station investigated this matter experimentally. In one instance the vines were pinched when they were 3 feet long, and the laterals were again pinched when one or two fruits had set on each. In another instance the main vine was pinched, but no laterals. The average total weight of melons produced per hill with three different varieties when the main vine and laterals were pinched was 17 pounds; when the main vines only were pinched, 14.4 pounds, and when the vines were allowed to grow naturally 16 pounds. The conclusion is drawn that there is little, if any, gain derived from pinching the vines, and in any case the extra cost for the work is likely to counterbalance any increase in productiveness.

The large number of staminate (pollen-bearing) blossoms which appear first on muskmelons have been thought to be a drain on the vines. The New Hampshire Station found that removing these blossoms as they appeared on the vines did have a tendency to increase the productiveness of the melons, but not to a degree sufficient to pay for the time involved. In the experiment work reported, from 150 to 300 staminate flowers were picked daily from about ten hills.

The right time to gather muskmelons for the market is difficult to determine and varies with the different varieties. On this subject the New Hampshire Station says:

> There seems to be no general rule for the best time to pick muskmelons equally applicable to all varieties. To allow them to ripen or turn yellow upon the vines usually results in a loss of the fine flavor and desirable texture of the flesh. With most of the smaller or Gem type, and many of the medium class, as soon as the melon begins to ripen it cracks about the stem more or less. As soon as this takes place and the fruit comes off easily, leaving the stem behind, the fruit should be gathered and put in a cool place or sent to market. This cracking about the stem is very noticeable with some varieties from their excreting a few drops of bright red or salmon-colored juice.
>
> In some of the larger varieties the stem does not separate from the fruit, or else when it does it leaves too large a hole in the rind. In such cases it is best to cut the stem, leaving the lower portion attached to the fruit. Perhaps the most desirable method of telling when these larger melons are ripe is to watch carefully for the first signs of yellowing, which usually appear first in the middle portion of the fruit. As soon as these traces of yellow are seen they should be

[a] U. S. Dept. Agr., Farmers' Bul. 149, p. 15.

picked. The conditions of the weather have much to do with the fruit ripening. On hot days fruit ripens very quickly and it is often advisable to make two pickings, one early in the cool portion of the morning, and again in the afternoon.

As the result of a test of a large number of varieties of muskmelons, the New Hampshire Station recommends the following for culture in that State: *Gem type*—Oval Netted Gem, Golden Netted Gem, Netted Gem, Rose Gem, Paul Rose, and Emerald Gem; *Medium type*—Extra Early Hackensack, Kinsman Queen, Satisfaction, Chicago Nutmeg, Improved Jenny, New White Japan, Nectar of Angels, Extra Early Cantaloupe, and Acme; *Large long type*—Granite State, Long Yellow, and Improved Cantaloupe. In a more recent bulletin Professor Rane recommends the following varieties for garden culture in New Hampshire: Emerald Gem, Rockyford or Netted Gem, Montreal, and Long Yellow.

The New York Cornell Station states that on Long Island and about New York City Emerald Gem is probably the most popular variety, with Hackensack a close second. In western New York Netted Gem is the leading variety, followed closely by Paul Rose and Surprise. At the experiment station Osage was one of the best melons tested.

Emerald Gem produces fruits of small size (from 1 to 2 pounds). These have flattened ends, are shallow ribbed and lightly netted, and the flesh is salmon colored. Rockyford or Netted Gem produces melons of about the same size and weight as Emerald Gem. They are oval shaped, shallow ribbed, netted, and green fleshed. Paul Rose is an early variety, belonging to this class, but has salmon-colored flesh. Montreal produces a medium-sized (3 to 6 pounds), oval-shaped, shallow-ribbed, netted, green-fleshed melon. Long Yellow produces a large (over 6 pounds) melon, which is long-shaped (two to three times as long as broad), deep-ribbed, lightly netted, with salmon-colored flesh. It belongs to the true cantaloupe class and is a midseason variety. Hackensack is also a true cantaloupe. Its fruits are of medium size (3 to 6 pounds), flattened at the ends, prominently netted, and have green-colored flesh. Surprise belongs to the same class as Hackensack, but has salmon-colored flesh. It is a late variety. Osage produces medium-sized (3 to 6 pounds), oblong melons, which are shallow ribbed, very nearly smooth or slightly netted, and have a salmon-colored flesh. It is a midseason variety and fruits over a long period.

ROCKYFORD MUSKMELONS.[a]

The Rockyford muskmelon, which is now so extensively sold in the markets of the United States, is simply the Netted Gem variety as selected and improved by growers in the region of Rockyford in the Arkansas Valley, Colorado, where they are grown under irrigation and where otherwise ideal conditions apparently exist for the produc-

[a] Compiled from Colorado Sta. Buls. 62 and 85.

tion of melons of the highest quality. The Rockyford variety is now grown extensively in other parts of the United States, and probably a large proportion of the melons sold in eastern markets under this name are derived from this source or are simply the ordinary netted gem produced by local growers. The true Rockyford melon does not come into the market in any quantity before the middle of August.

According to P. K. Blinn, of the Colorado Station, a perfect Rockyford cantaloupe should be "slightly over 4 inches in diameter and about $4\frac{5}{8}$ inches long; it should have silver-gray netting that stands out like thick, heavy lace, practically covering the entire melon, save the well-defined slate-colored stripes; these should run the whole length of the melon, clear cut as if grooved out with a round chisel, and terminating at the blossom and in a small button. The interstices in the netting should be light olive green, that turns slightly yellow when the melon is ready for market. * * * The flesh should be thick and firm, of a smooth texture, and free from watery appearance, rich and melting in flavor. The shipping and keeping qualities depend largely on the solidity of the melon, so the seed cavity should be small and perfectly filled with seed. The color of the flesh near the rind should be dark green, shading lighter toward the seed cavity, which should be salmon or orange in color. The flesh is often mottled with salmon, and not uncommonly the entire flesh is of that color."

The method of growing the Rockyford melon in the Arkansas Valley is described by H. H. Griffin substantially as follows: The melon requires a deep, warm, sandy-loam soil well supplied with humus. In comparative tests by the Colorado Station of alfalfa sod and cropped land manured with well-rotted barnyard manure or bone meal applied in the hill, the best results were obtained on the alfalfa sod. In this case the product was nearly doubled, the quality was better, and the ability to resist fungus troubles greater. Alfalfa sod brought maximum returns, and in turn the melon easily subdued the alfalfa and put the land in splendid condition for succeeding crops. The land is prepared by rather deep plowing, harrowing, and leveling. Furrows are then run with a shovel plow from 6 to 7 feet and the seed is planted by the side of the furrow in hills from 5 to 6 feet apart in the rows. Planting should be done from the 1st to the 10th of May. The carefully selected seed (10 to 15 to each hill) should be planted not over 1 inch deep. Seed is germinated by running the irrigation water into the furrows and allowing it to reach the seed by being drawn up through the soil (subirrigation, as it is termed). When the plants have four leaves, they are thinned to three in each hill. At this time the permanent irrigating furrows are run and cultivation ceases, except such hoeing as is needed to keep down weeds.

It is common to irrigate every ten days, paying little attention to the needs of the plant. The tendency is to irrigate too often early in the season.

The most water is required about the time the blossoms commence to set well, previous to this giving only enough to keep the plant growing well. When the plant commences to bloom profusely, irrigate thoroughly and afterwards give only so much water as will keep the plant in good, thrifty condition.

When the melons begin to ripen in August they are picked into sacks carried over the shoulders of the pickers, and are at once taken to the packing sheds, where they are crated.

The standard crate holds 45 perfect melons, in three tiers of 15 melons each, and weighs about 69 pounds. There are also used to some extent the two-layer crate, which is two-thirds the size of the standard, and the "pony" crate, holding 45 melons, but smaller than those of standard size. The standard crate is (inside measurement) 22 inches long, 12 inches wide, and 13 inches deep.

When it is proper time to pick for shipment the stem slightly parts from the melon. No stem tissue should adhere to the melon, but there should be a smooth surface where the stem was attached. The netting and skin has a peculiar grayish appearance, which is easily distinguished when one becomes accustomed to picking.

The cantaloupe is very perishable, and rapid transportation in refrigerator cars is required. By this means melons of good quality are placed in all of the markets of the Eastern States. The shipping period (from the same vines) should extend over not less than thirty days; a more rapid ripening than this is generally indicative of unhealthy conditions. As high as 300 crates per acre have been taken from alfalfa sod, but 100 to 150 crates of marketable melons per acre is considered a good yield.

For many years after the industry was established the Rockyford melons were remarkably free from attacks of insect and fungus enemies. In recent years, however, much injury has resulted from these causes, especially from the blight, but the experiments of the Colorado Station have shown that this disease may be controlled to a large extent by spraying with Bordeaux mixture. An explanation of the popularity of the Rockyford melons is that they are well graded and usually uniform in quality. As Mr. Blinn explains, the Rockyford cantaloupe is a product of years of systematic selection, and it requires the same methods to maintain its excellence as were employed in its development. Without care in selection of seed, the natural tendency to vary will soon cause a good strain of Rockyford melons to revert to an undesirable type.

COLD STORAGE OF FRUITS.[a]

Cold storage is of vital interest to fruit growers. By means of it the season of many fruits is greatly prolonged, gluts in the market are avoided, the prices received are frequently augmented, and the net returns much increased. It is of interest, therefore, to note that recent experiments by this Department and by the experiment stations in New Hampshire, Illinois, Canada, Iowa, and West Virginia have

[a] Compiled from Illinois Sta. Circs. 44, 67; New Hampshire Sta. Bul. 93; Ontario Agr. Col. and Expt. Farm Bul. 123; U. S. Dept. Agr., Bureau of Plant Industry Buls. 40, 48.

thrown much light on some of the more serious problems encountered in the cold storage of apples, pears, and peaches.

The purpose of cold storage is to prolong the marketable life of the fruit. After the fruit is once harvested the ripening processes go steadily forward until decay sets in, resulting finally in complete rottenness. Ripening progresses much more slowly and any disease which may be on the fruit develops less rapidly at low temperatures. Some fruits that at the ordinary temperature of the season will decay in four or five weeks or less can be kept as many months when properly handled and kept at a low temperature such as is afforded by cold storage. The length of time which fruit can be kept in cold storage without loss of quality has been found to depend on the degree of ripeness of the fruit when put in storage, the temperature at which it is kept in the storage house, the kind of package employed, and a number of other factors.

Time to harvest fruit kept in cold storage.—As to the degree of ripeness that fruit should be allowed to attain, investigations at the Illinois Station indicated that mature apples kept much better in cold storage than immature apples. The mature fruit in storage showed a much smaller percentage of rot, was less subject to scald, did not shrink as much, and had a better color and better keeping qualities when removed from storage. Powell and Fulton, of this Department, investigated this subject exhaustively. Their conclusions relative to apples are as follows:

> An apple usually should be fully grown and highly colored when picked to give it the best keeping and commercial qualities. When harvested in that condition it is less liable to scald, of better quality, more attractive in appearance, and is worth more money than when it is picked in greener condition. An exception to the statement appears to exist in the case of certain varieties when borne on rapidly growing young trees. Such fruit is likely to be overgrown, and under these conditions the apples may need picking before they reach their highest color and full development.

With pears Powell and Fulton found that both on account of quality and keeping ability "pears should be picked before they are mature, either for storage or for other purposes. The fruit should attain nearly full size and the stem should cleave easily from the tree when picked. * * * The quality of a pear normally deteriorates as it passes maturity, whether the fruit is in storage or not, or it is never fully developed if the fruit is ripened on the tree. The quality of the quick-ripening summer varieties deteriorates more rapidly than that of the later kinds. Much of the loss in quality in the storage of pears may be attributed to their overripeness."

The same investigators found that peaches, which are sometimes stored for two or three weeks for the purpose of avoiding a glut in the market or to fill in a gap between the crop of different regions, keep best if picked and placed in cold storage when highly colored but still

firm. It was found that if the fruit was mellow when put in storage it deteriorated more quickly, and if unripe it shriveled considerably.

Temperature of fruit in cold storage.—The Illinois Station has reported the results of experiments in storing apples at different temperatures. The experiments were made with Ben Davis and Winesap, stored at temperatures of 31°, 33°, 35°, and 37° F., respectively. The Ben Davis kept better and scalded less at 31° F. than at any other temperature. The difference was not so striking with the Winesap variety, but was in favor of the lower temperature. At the Ontario Agricultural College experiments in the cold storage of Fameuse apples indicated that they kept better at a temperature of 31° F. than at any higher temperature. The experiments of Powell and Fulton with a large number of varieties of apples grown under widely varying conditions of soil and climate and stored at different stages of maturity and in different kinds of packages and wrappers, also strikingly showed that a temperature of 31° to 32° F. retards the ripening processes more than a higher temperature and favors the fruit in other respects. They also found that a temperature of 32° F. is more favorable to the long keeping of pears and peaches than any higher temperature.

Handling fruit after picking.—The work of Powell and Fulton, referred to above, indicates that fruit ripens more rapidly at the same temperature if picked than if left remaining on the tree. Any delay in placing the fruit in storage after picking furthers the ripening of the fruit and the development of diseases, and injures the keeping quality. This is especially true when the fruit is harvested in warm, moist weather.

Rhode Island Greening, Tompkins King, and Sutton apples picked September 15 [temperature 62° F., humidity 84], 1902, and stored within three days were firm till the following March, with no rot or scald; but fruit from the same trees not stored till two weeks after picking was badly scalded or decayed by the first of January. None of the immediate-stored fruit was scalded or decayed by the 1st of February, but the delayed Sutton and Rhode Island Greening apples were soft and mealy, and one-third were scalded at that time, while nearly 40 per cent of the delayed Tompkins King were soft and worthless. The commercial value of these varieties was injured from 40 to 70 per cent by the delay in storing. Apples of these varieties picked from the same trees on October 5 [temperature 53° F., humidity 80], 1902, and stored immediately, and also some stored some two weeks later were less injured by the delay, as the temperature and humidity were not sufficiently high to cause rapid ripening or the development of the fruit rots.

Properly packed Bartlett pears keep in prime condition in cold storage for six weeks when stored, within forty-eight hours after packing, in a temperature of 32° F. When storing was delayed until four days after picking there was a loss of from 20 to 30 per cent from softening and decay. Kieffer pears picked later in the season when the weather was cooler and delayed only forty-eight hours before placing in storage kept in perfect condition until late winter; but when delayed

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ten days the fruit from young trees began to discolor and soften at the core within a few days after entering the storage room, although the outside of the pears appeared perfectly normal. Peaches were found even more delicate than Bartlett pears, and any delay in placing them in cold storage after picking was found to greatly injure their keeping quality.

Packing fruit for cold storage.—The advantage of small packages in cold storage comes from the fact that the fruit in them cools down quickly and the ripening processes are promptly checked. In large packages like a barrel the fruit in the center cools down slowly and may continue to ripen and even decay while that on the outside, which cools down more quickly, may still be firm and in prime condition. Fruits that ripen in warm weather, like peaches and early pears and apples, should be stored in the smallest commercial package practicable, while fruits which mature late and are harvested in cool weather may be stored in large packages. Powell and Fulton found that closed packages are best for apples that are to be stored for any length of time, since fruit in ventilated packages is likely to be injured by wilting. Closed packages also proved most satisfactory for pears and peaches. Reynolds and Hutt at the Ontario Agricultural College found that apples and pears keep best when wrapped singly in paper and packed in a shallow box not much larger than a bushel. Powell and Fulton state, with reference to the wrapping of pears, that "early in the season the influence of the wrapper is not so important, but if the fruit is to be stored until late spring the wrapper keeps the fruit firmer and brighter. It prevents the spread of fungus spores from one fruit to another and thereby reduces the amount of decay. It checks the accumulation of mold on the stem and calyx in long-term storage fruits, and in light-colored fruits it prevents bruising and the discoloration that usually follows." Wrapped peaches also retained their firmness and brightness for a longer period than unwrapped fruit, and the wrapping proved a great protection to the fruit against bruising. In the case of apples, the New Hampshire Station states that wrapped fruit kept much better than unwrapped, particularly during the latter months of storage. But little difference could be noted until after March 1. Powell and Fulton found the same advantages in the use of wrappers for apples as for pears, and think that "in commercial practice the use of the wrapper may be advisable on the finest grades of fruit that are placed on the market in small packages." Common unprinted newspaper has been found a very satisfactory kind of wrapping material. A double wrapper retards ripening and wilting to a greater extent than a single wrapper. A good combination is unprinted newspaper next to the fruit with a more impervious paraffin paper wrapper on the outside.

Handling fruit after removal from cold storage.—Fruit placed in cold storage is nearer the end of its life when finally removed than when

first put in storage, and in a warm temperature will break down quicker. In a cool temperature it may stand up for weeks or months after removal. It is very desirable that after removal the fruit be kept as cool as possible and brought up to the surrounding temperature very slowly. If brought suddenly from a cold-storage room into a warmer atmosphere, moisture may condense in large enough quantities to thoroughly wet it. This condition favors the growth of fungus diseases and hastens decay. Reynolds and Hutt report an experiment in which a basketful of such wet fruit was allowed to remain in the basket as they were, while the fruit from another like basket was spread out thinly on a table and allowed to rapidly dry off. Both baskets were then placed in a cold cellar for ten days. At the end of that time 30 per cent of the wet fruit was discolored and 12 per cent rotten, while of the fruit that had been dried off but 11 per cent was discolored and 5 per cent rotten. The best way, of course, is to gradually warm up the fruit, so that no moisture forms on it at all. In any case, after the removal of fruit from cold storage it should be used up as rapidly as possible.

Can farmers afford to build cold-storage houses?—The large cold-storage houses in the cities are usually cooled by mechanical refrigeration. This method is too expensive for use on a small scale in the country. Ice and the natural temperature must be depended upon.[a] The Illinois Experiment Station has reported the details of building a storage house capable of holding 2,500 barrels of apples and dependent upon ice for controlling the temperature. This house was built as simply and cheaply as possible, and for the most part by unskilled labor. It cost when completed $3,430.40. During the season 2,000 barrels of apples were placed in it by October 5 and 70 tons of ice put in the refrigerator. The temperature of the storage room fell rapidly after the ice was put in to about 33° F., and this temperature, or a little lower, was maintained throughout the experiment. The cost of storage per barrel of fruit in this building up to April 23, or about seven months, was 19.1 cents, or 30.9 cents less than the usual charge for apple storage. Based upon these results, it is estimated that the building, if stored to its full capacity each year, would pay for itself in five years.

The fruit in the building was examined from time to time during storage. Without exception it kept well. "There was no scald, no withering. The fruit remained plump and in perfect condition, and the percentage of rotten fruits was very small." The results are believed to plainly show the utility of buildings of this character cooled by ice. "Commercial growers of apples can well afford to invest in similar houses and thus add greatly to their profits. * * *

[a] See previous article on cold storage on the farm in U. S. Dept. Agr., Farmers' Bul. 119, p. 11.

The advantages of such houses, located either in the orchard or in proximity to the nearest railway switch, may be briefly stated as follows:

(1) The selling period of fruit could be greatly prolonged.

(2) Fruit could go from the tree immediately into storage and be cooled to such degree as would arrest ripening processes.

(3) Fruit could be stored in temporary packages, and final grading and packing deferred until the hurry of the picking season was over.

(4) In the event of scarcity or high price of barrels during the busy season, fruit could be stored in bulk to be packed later when acceptable barrels could be obtained at satisfactory prices.

(5) The facilities for handling the fruit would enable the grower to give better attention to the degree of maturity, and pick at just the proper time.

Another problem studied by the same station was whether the small grower of fruit could afford to insulate a cellar and cool it with ice during the early part of the season, and later depend upon the natural temperature. The conclusions arrived at from this work are to the effect that it is not economical to build a cold-storage room in the ground in Illinois. The earth is too good a conductor of both heat and cold. The amount of ice required in the early part of the season was excessive and could not be relied upon to reduce the temperature of the cellar to a sufficiently low degree. Later, when the admission of outside temperature was relied upon, fluctuations that were detrimental could not be avoided. "As a consequence of fluctuating and commonly too high temperatures, the fruit did not keep well. The percentage of rot was quite high. But a possibly worse feature was that the sound fruit was more or less wilted."

The results of the work at the Illinois Station would seem to show that commercial fruit growers or communities in which considerable quantities of fruit are grown might profitably erect cold-storage houses cooled with ice, rather than pay the usual charges of 50 cents per barrel for cold storage in commercial warehouses, and, further, that insulated cellars do not make satisfactory cold-storage rooms in Illinois. The temperature can be more easily controlled in buildings above the ground than in those built in the ground.

SELECTION OF SEED CORN.[a]

Although the culture of corn in the United States is practically as old as American agriculture itself, and the improvement of the crop and creation of new varieties has been in progress from the beginning, it is within comparatively recent years and largely through the efforts of the agricultural experiment stations in collaboration with progressive farmers that scientific systems of corn judging and seed-corn selection have been devised. It is believed that the more general

[a] Compiled from Arkansas Sta. Bul. 51; Illinois Sta. Buls. 82 and 87; Iowa Sta. Bul. 68; Missouri Sta. Bul. 59; North Dakota Sta. Bul. 51; Ohio Sta. Bul. 140; Bul. North Carolina State Bd. Agr., 24 (1903), No. 9; Univ. Tenn. Record, 7 (1904), No. 1, p. 13.

adoption in practice of scientific methods of judging, selection, and growing of seed corn throughout the corn-growing areas of the country would soon show marked results in the improvement of corn and the maintenance of variety standards. The great differences in the yields of varieties grown under the same conditions which is often forcibly brought out by the results of variety tests at the experiment stations; the fact that the average yield of corn in the United States is only about 27 bushels per acre; the possibility of changing the composition of the grain; the tendency of the crop to vary—which has already given rise to many varieties—and other similar points indicate the value and possibilities of corn improvement and the lines along which the work may profitably be carried on. Next to the better and more thorough cultivation of the soil, the proper selection and production of seed corn is perhaps the strongest factor in increasing the yield, and the more recent work of several of the experiment stations in this connection, together with their recommendations, are here briefly outlined.

The farmer generally procures seed corn by importing improved seed or by selecting seed ears from his own crop. Since it is to his interest to know exactly what variety of corn he is planting and the value of the seed he is using, the method of buying or importing the seed corn does not always prove satisfactory. Where good seed is obtainable this method has the advantage of enabling the farmer to begin his work with a variety that has already reached a certain standard of excellence, and which may for this reason prove to him a saving of several years of labor and expense. This method is to be recommended wherever the corn grown on the farm is only of ordinary grade. Corn, however, is readily affected by changes in conditions of soil and climate, and in obtaining a variety from a distance, perhaps from a very different latitude, its standard of excellence is likely to be impaired and satisfactory results delayed until the variety, after two or three years of growth under the new environment, has become acclimated.

The results obtained at different institutions teach some interesting lessons in this respect. In 1902 the North Carolina Board of Agriculture obtained from the Illinois Experiment Station seed of Leaming corn, one of the best varieties grown in Illinois, but under North Carolina conditions this corn ranked last in a test of 13 varieties. This result was probably due to some extent to the difference in latitude, but it is not likely that the entire depression in the yield was caused by this factor. A test of this kind on a larger scale is reported by the Arkansas Experiment Station. Samples of seed corn were obtained from 18 different States in 1898 and 20 in 1899, and planted in comparative plats. Eleven varieties, including such well-known sorts as Leaming, Golden Beauty, Hickory King, Golden Dent, Champion White Pearl, Early Mastodon, and White Dent were compared. The

difference between yields of the same variety from different sources in the same latitude was sometimes greater than the average difference between varieties from different latitudes. The yields from northern-grown seed of Golden Dent varied from 15.9 to 48.8 bushels per acre. The average yield of 75 samples of seven varieties from seed grown north of the thirty-eighth parallel was 25.78 bushels per acre; 49 samples of the same varieties from seed grown between the thirty-eighth and thirty-fifth parallels, 32.76 bushels per acre, and 31 samples of the same varieties from seed grown south of the thirty-fifth parallel, 31.48 bushels per acre. "The results of the two years experimentation indicate that seed corn grown in the same or nearly the same latitude as that in which it is to be planted will give the best results, and that seed grown in the neighborhood where they are to be planted are preferable to those grown farther north or farther south." The North Dakota Station states that the best corn for a given locality in that State is usually a variety which has grown and ripened seed for the longest period of years in that locality, provided it has been kept pure and true to type and adapted by selection to the particular climate and soil. Attention is called to the fact that Mercer Flint corn, a comparatively early variety when propagated from North Dakota-grown seed, has failed to ripen at the station when the seed was secured from South Dakota or southern Minnesota.

In obtaining seed corn from other than home sources it is preferable to secure it in the ear, because in this form it can be judged and all ears not suited for seed may be discarded, while if it is shelled no such selection can be made. This is a well-recognized fact and many seed-corn growers offer their seed in the ear.

The selection of seed corn by the farmer from his own crop is usually accomplished in three different ways: First, by going into the field before the harvest and selecting the ears with desirable characteristics produced on the best stalks; second, by selecting the ears while harvesting is in progress; and third, by picking out the seed after the corn has been gathered and put in the crib. The first of these methods is preferable, because the work is better performed when its special and only purpose is the selection of the seed, and when the entire plant and not simply the ear can be taken into account. The other methods, while not without value, do not admit of the thoroughness and carefulness required for the proper execution of the work. Where field selection is practiced it is advisable to gather more corn than is actually needed for seed in order that the ears may again be selected before planting time. In the final selection the work may be facilitated and made more effective by conveniently arranging the ears on benches or boards and comparing each one with a type ear picked out with regard to all the characters that belong to a standard ear of seed corn.

These characters as outlined by the Missouri Experiment Station

are briefly noted. The principal object in view is the production of the greatest quantity of kernels, and all the characters of the plant should tend in that direction. The shape of the cob should allow of the greatest number of large and uniform kernels. The ear which most nearly conforms to these requirements is cylindrical, or varies only slightly from the cylindrical form, and is about 10 inches in length and 7.5 inches in circumference, the proportion of length to circumference being as 4:3. The butts and tips of the ear should be well filled out with kernels, and the rows of kernels as well as the kernels in the row should be firmly pressed together, so that the ear is rigid and compact. The grain should constitute from 86 to 90 per cent of the ear by weight. Each ear may be readily tested before planting by first weighing the ear and then the shelled corn obtained from it. With the kernels uniform in size a perfect stand is more likely to be secured, and the percentage of grain is also larger than when the kernels are smaller at either end of the ear. The kernels should be wedge shaped, with straight edges, leaving no space between the rows or the kernels, and thus making the whole grain layer around the ear compact. Figs. 3, 4, 5, 6 and 7.

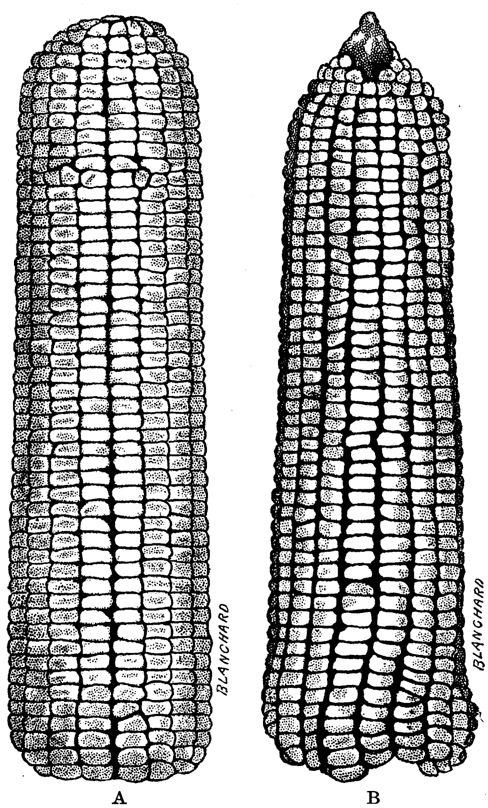

FIG. 3.—Well-shaped and poorly-shaped ears of corn: A, well-shaped; B, poorly-shaped.

The value of kernels uniform in size with regard to the stand is illustrated by the results of planter tests made at the Iowa and Tennessee stations, which show the number of kernels dropped when they were uniform and when they were unequal in size. At the Iowa Station when uniform-sized kernels were used the planter in one test dropped 2 kernels 8 times and 3 kernels 92 times out of 100. With kernels irregular in size the number of times 1, 2, and 4 kernels were dropped per 100 was largely increased. The tests made at the Tennessee Station also showed that the number of kernels dropped by the planter was more nearly uniform when grains of equal size and shape were used. Uni-

formity in the size of seed means less work, as it practically eliminates the necessity of thinning and gives a more even stand and a better yield.

As an improvement on simple field selection, experiment station workers and other corn breeders recommend that seed corn be grown from selected ears and kernels in a special field or breeding plat. The following method is suggested by the Illinois Station:

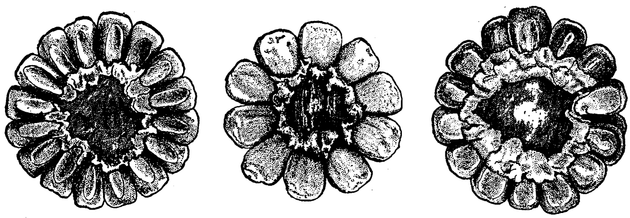

FIG. 4.—Arrangement of kernels and proportion of cob in good and poor ears.

Forty selected ears are planted in 40 separate parallel rows, one ear to a row. Consequently the breeding plat should be at least 40 corn rows wide and long enough to require about three-fourths of an ear to plant a row. It is well to shell the remainder of the corn from all of the 40 ears, mix it together, and use it to plant a border several rows wide entirely around the breeding plat to protect it, especially from foreign pollen. * * * The very best ears of seed corn are planted in the center rows of the breeding plat, the remainder of the ears being planted in approximately uniform gradation to either side, so that the least desirable ears among the 40 are planted in the outside rows, and in the final selection of the best field rows from which the next year's seed ears are to be taken some preference is given to the rows near the center of the plat.

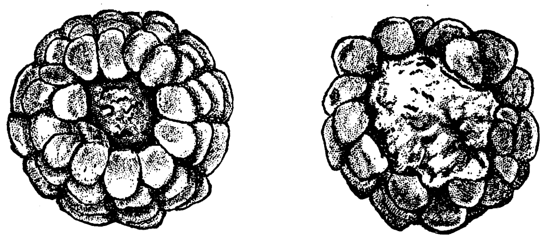

FIG. 5.—Well-filled and poorly-filled butts.

In the practice of the Illinois Station every alternate row is detasseled before the pollen matures to prevent self or close pollination of the future seed, which is selected from these detasseled rows. Plants in the remaining rows which are imperfect, dwarfed, immature, barren, or otherwise undesirable are also not allowed to mature pollen. In this system of growing one row from a particular seed ear the first step in the selection of seed is the selection of the rows, which frequently show marked individuality, and finally the selection of individual plants from which seed ears may be taken. The points here considered are as follows:

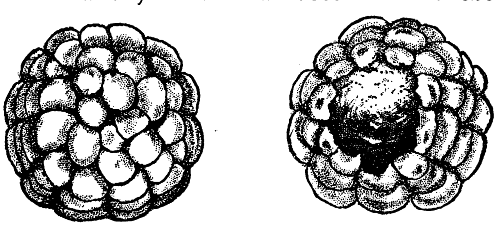

FIG. 6.—Well-filled and poorly-filled tips.

The percentage of "stand" of plants, the height and physical proportions of the plant, the character and amount of foliage, the position of the ear on the stalk,

the length and size of the ear shank, the percentage of ear-bearing plants, the time of maturity, the total yield of the row, the average weight of the ears, and the number of good seed ears which the row produces.

All the apparently good ears borne on good plants, in a good position and with good ear shanks and husks, are harvested from the detasseled rows which have not been rejected. The weight of best ears and the total yield is determined for each row and a performance record for each individual ear of seed corn established. In the final selection of 40 seed ears for the next breeding plat it is considered preferable to have as many as possible of the 10 best rows represented. Each lot of best ears from the 10 best rows, and finally each of the 40 ultimately selected seed ears, is labeled, and the number and the description of the ear, composition of the grain, performance record of the row, and other data are permanently recorded, and as this work is carried on from year to year, a pedigree dating back to the beginning of the breeding plat or the existence of the records is established for every ear of seed corn. The method of determining in a measure the composition of the corn, by a simple mechanical examination, is given later on.

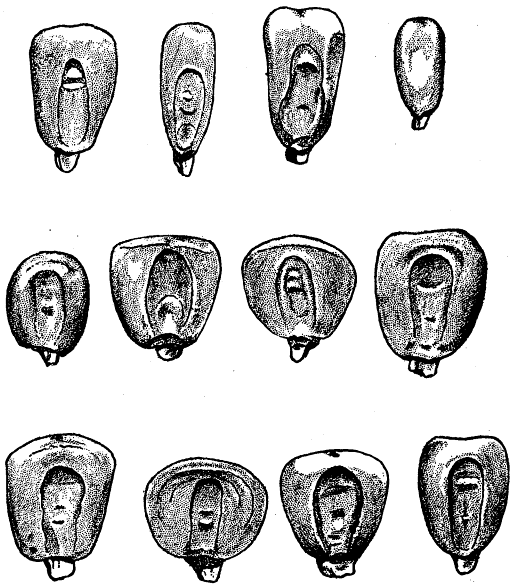

FIG. 7.—Well-shaped and badly-shaped kernels. The first and twelfth kernels have the best form.

The Missouri Experiment Station sums up the principle of selection as follows:

Begin with the whole field or breeding plat, from which select the best plants according to performance. From these best plants select by the eye and by measurements the best ears. From these best ears select the best kernels. From these best kernels select the few very best for the breeding plat and plant the whole field with the remainder.

By isolating the plat, crossing by foreign pollen can be prevented or minimized.

Attention has been called to the fact that corn should be grown and bred for special purposes—i. e., corn for feeding should have a high protein content, corn used in the manufacture of starch and glucose should be rich in starch, and corn for the production of oil should contain a high percentage of that substance. Corn contains so much starch, being in fact a natural starch producer, that a special effort to increase its starch content is needless; but for the other purposes men-

tioned higher percentages of protein and oil are very desirable. Several experiment stations have taken this matter into consideration, and foremost among them the Illinois Station, where experiments in the selection of corn with a high protein and a high oil content have been in progress for several years. The results obtained there have shown that the protein and oil content of corn can be increased by selection, and that high protein seed may be secured by selecting the kernels which have a large proportion of horny parts and high oil seed corn by selecting for a large proportion of germ (figs. 8 and 9).

Good seed corn has the qualities which tend to produce a perfect stand of vigorous plants which will produce sound, fully mature, standard ears, typical of the variety. The vitality of seed corn should always be determined, because the stand, and consequently the yield, depends so largely upon this factor. Seed corn with a percentage of germination below 95 can not be recommended for planting. Improper drying and storing frequently impairs the vitality of seed corn, but if the ears are well cured and kept dry in storage no injury is likely to result.

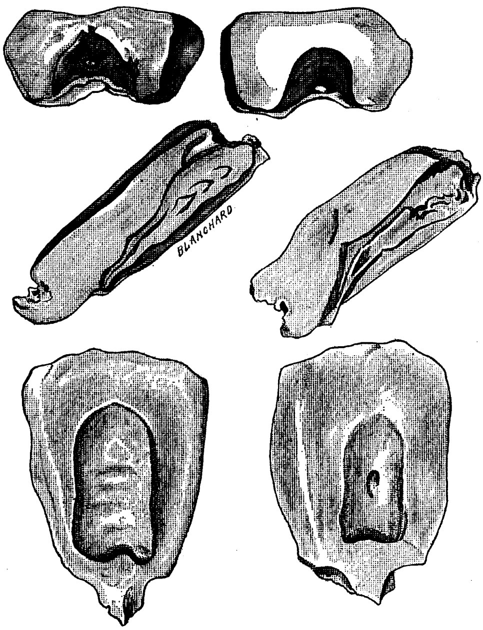

FIG. 8.—High-protein (on the left) and low-protein (on the right) kernels.

One of the simplest methods of testing seed corn, and one which requires little attention, is to fold up 25 or 50 kernels of the corn in a piece of wet paper and put it in a box. There is nothing better than a cigar box for this purpose. The paper should be thoroughly wet and several thicknesses used, so that it will not dry out. It is well to place some moistened pieces of paper in the bottom of the box and again on top of the samples to hold the moisture.

In order to make a thorough test it will be well to prepare at least five or six samples like the one described above. They should all be put into the same box and a string tied around it, so as to hold the cover on tight, to prevent the corn from drying out. At the end of three days it will be well to examine the corn, and if the papers are getting dry they can be moistened. At the end of five days the final examination should be made.

BREAD AND TOAST.[a]

Toast is a favorite article of diet, especially with English-speaking races, being quite commonly considered more digestible, and, by

[a] Compiled from California Sta. Rpt. 1902-3, p. 100; Minnesota Sta. Bul. 74.

many, more palatable than untoasted bread. A similar article, zwieback, enjoys much the same position in the diet of the Germans and some other races.

H. Snyder, at the Minnesota Experiment Station, studied the comparative composition and digestibility of bread and toast. The bread was made from straight-grade patent flour, and the toast was prepared from the bread after it was 12 hours old. It was first dried in the oven and then toasted in the usual way with a wire toaster. Professor Snyder found that the main difference between bread and toast, as regards chemical composition, was in the water content, the toast being much drier than the bread owing to an evaporation of water during the process of toasting.

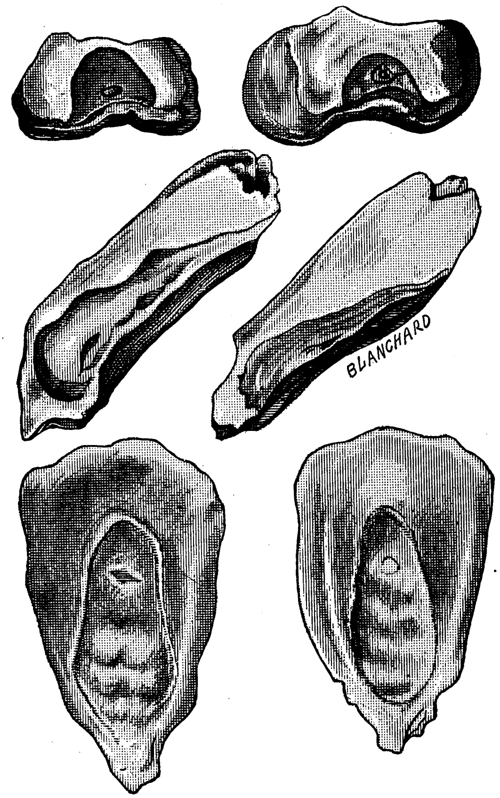

FIG. 9.—High-oil (on the left) and low-oil (on the right) kernels.

As regards changes in the nutritive value due to toasting, it appeared that the character of the nutrients, particularly the carbohydrates, was more markedly affected than the percentage amounts. The heat employed changed a part of the starch to dextrin, a soluble carbohydrate. On the other hand, the proteids were changed to less soluble compounds.

Digestion experiments were made with man on a diet of bread and milk, and toast and milk, which showed that on an average 87.1 per cent of the protein of the bread was digested, as compared with 84.7 per cent in the case of the toast. As regards the digestibility of carbohydrates, the two rations were much alike, somewhat over 97 per cent being digestible in both cases. A similar agreement was found in the case of energy, over 91 per cent of that supplied by both rations being available for the needs of the body. These values show nothing of the rate or comparative ease of digestion, but these points were studied by artificial digestion experiments, in which bread and toast were submitted to the action of malt diastase. Under uniform conditions, in a given time, 14.68 per cent of

the starch of bread was rendered soluble or digested, as compared with 21.38 per cent in the case of toast. In other words, the starch of toast, i. e., the principal nutrient in it, is apparently more readily digested than the starch of bread.

The fact that toast is somewhat more readily but not quite as completely digested as bread does not detract from its value as a food for invalids and others who require a sterilized food, but it suggests that, as far as the availability of the nutrients is concerned, the bread is to be preferred to the toast.

At the California Experiment Station various problems connected with toast have been more recently studied by E. W. Hilgard. It was found that in making light-colored (yellow) toast a temperature of about 150° C. was required, and for dark (brown) toast a temperature of 170 to 175° C., the entire bread being transformed in each case, i. e., toasted through and through. Toast was also made by the more usual household method, each side of the slice being browned only on the surface.

The following table shows some of the changes in composition due to toasting, for comparison the results obtained when bread was simply dried at 100° being also included:

Changes due to different methods of toasting bread.

Kind of toast.	Loss in weight on toasting.	Material soluble in water.	Material insoluble in water.	Albumen in soluble portion.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Bread heated 1 hour at 100° C	34.70	12.62	87.38	1.70
Light-colored (yellow) toast made at 150° C	35.30	12.45	87.55	
Brown toast made at 170° C	36.07	26.14	73.86	.91
Dark-brown toast made at 174° C		25.50	74.50	
Brown toast made at about 160° C., by household method		21.77	78.23	[a]1.90

[a] Bread made with milk; therefore the albumen is not directly comparable with other samples.

It will be seen that when bread was toasted at 150° C. it lost only a little more in weight than when heated at 100°, although when kept at the lower temperature for an hour a slice of bread one-half an inch thick was converted into a light-colored toast very similar to the light yellow toast. Such toast is commonly thought to be very suitable for persons of delicate digestion. According to the author, it does not contain much more soluble matter than raw bread. In the brown toast made at 170° the soluble matter was more than double that found in the toast made at 150°, and at the same time there was a marked decrease in the amount of soluble albuminoids as compared with raw bread.

The observed changes in composition are in accord with Professor Snyder's observations. In thoroughly toasted bread the change of starch into soluble compounds and the sterilization are factors which may be sufficient to account for the increased digestibility noted in the experiments and also for the commonly observed fact that such toast is more readily digested by invalids than bread, but according

to Professor Hilgard the case is otherwise with the toast made by the ordinary household method. Such toast, he states in effect, is only browned delicately on both sides, the toasting changing the bread only to a very slight depth, so that the toasted layer on the two sides together will hardly exceed a millimeter (about 0.04 inch) in thickness.

When the toasting is carried only to the delicate yellow stage the increase in soluble matter will be insignificant, and the soft interior of the slice will be no more sterilized than it was in the baking of the bread. Thus neither increased solubility of the carbohydrates nor sterilization can explain the fact that such toast is nevertheless apparently easier of digestion by invalids than the bread from which it was made.

In view of these results Professor Hilgard believes that it is improbable that the beneficial effect of toasting bread is in the main due either to an increase of soluble ingredients or to sterilization. The experiments offer little more than a probable indication of the really effective conditions, but they point to the conclusion that not solubility, but the flavor produced by the toasting, is the true cause of the readier digestion of ordinary toast as compared with bread, probably owing to the fact that it stimulates the flow of digestive juices.

COOKING MEAT.[a]

The losses involved in cooking different kinds and cuts of meat and the consequent changes in nutritive value have been studied for several years at the University of Illinois in cooperation with this Department, and some of the results obtained have been noted in an earlier bulletin of this series.[b]

A recent publication of the Illinois Experiment Station reports the results of an extended series of tests carried on by Prof. Isabel Bevier and Elizabeth C. Sprague along these lines, especially as related to the ordinary household methods of cooking meat. Beef rib roast (the fourth rib) was chosen as the most satisfactory cut for the experiments, which included studies of the effects of temperature of roasting, length of cooking period, form and size of the roasting pan, and related topics. In the greater number of the tests an oven especially designed and constructed for the work was used, although for purposes of comparison one of the ovens on the market in which the cooking is continued at a moderate heat for a long period was also employed.

As regards temperature, authorities on cookery agree quite generally that meat should be subjected at once to a degree of heat which will sear the outside of the roast so that the juice may be retained, but they differ greatly as to the temperature or time required to accomplish this result, nor is the effect of temperature on the losses

[a] Compiled from Illinois Sta. Circ. 71.
[b] U. S. Dept. Agr., Farmers' Bul. 162.

in weight or flavor of the cooked roast definitely understood. In 14 experiments in which temperature was especially considered the heat of the oven ranged from 83 to 260° C. (182 to 500° F.), and the total loss in weight (due largely to the evaporation of water) varied from 5.9 per cent to 20.6 per cent, or less than one-sixteenth of the total weight of the beef roast used. In general, the higher the temperature the greater the loss in roasting. A temperature of not less than 249° C. (482° F.) was required for the development of the characteristic flavors of cooked meat. When meat is baked for a short time at a very high temperature, 260° C. (500° F.), the outside layer is apt to be overdone and the center too rare for use. When baked very slowly in the oven mentioned, at a comparatively low temperature, the roast was very evenly cooked throughout and the juices were well retained, but the savoriness and flavor produced by higher temperatures were lacking. Even if the meat was seared before cooking, it did not retain this appearance, but came from the oven gray and unattractive. "If browned at the end of the process the outside became tough and seemed to have the characteristics of overcooked albumen emphasized."

The length of time the cooking should be continued to secure a product of definite character is a matter on which opinions differ. Some authorities recommend cooking for fifteen minutes per inch of thickness of the roast. A rule commonly found in cookery books is to roast fifteen minutes for each pound and "fifteen minutes for the oven" if rare meat is desired and twenty minutes for a well-done roast.

The effects of cooking for different lengths of time under uniform conditions were studied with special reference to the relation, if any, between losses in weight and thoroughness of cooking. The loss of weight in meat, chiefly water, is accompanied, the authors note, by other physical changes. Thus, if the temperature is sufficiently high, the outside becomes brown or gray while the interior retains its juice and bright-red color.

If the high temperature has been continued a sufficient length of time, the interior of the meat and its juice also lose their red color—the former becoming gray or brown and the latter colorless or slightly yellow. This colorless juice by contact with the brown surface of the roast may become brown in color.

The different degrees in the cooking of meats are distinguished by the terms "rare" and "well done." There is a degree between these two extremes, not easy to distinguish, when the outer muscles only are gray, the center of the roast being slightly pink. This degree is called "medium." The juice is less in quantity than in rare meat and may be either a darker red or only tinged with color.

It would appear from the results of the experiments that there is a relation between the time of cooking and the color of the cooked meats, and that under the experimental conditions, thirteen minutes per pound and thirteen minutes to the oven, gives that degree of cooking known as "rare." Fifteen minutes to the oven and fifteen min-

utes to the pound produces the degree of cooking known as "medium." Twenty minutes to the oven and twenty minutes per pound gives that degree known as "well done." It is evident that the time element is an important one, both as regards the degree of cooking and the losses incurred in the process.

The effect of basting was studied, and in the opinion of the authors the only definite conclusion which can be drawn regarding the differences between the basted and the unbasted meat was that when cooked under otherwise identical conditions the former was always the rarer. Evidently the temperature of the roast was lowered by basting it.

Some interesting facts were brought out in the tests in which the character, shape, and size of the cooking utensils were taken into account. In a comparison of an oval concave pan with open and closed flat rectangular pans, it was found that so far as total losses in weight were concerned the shape and size of the pan did not seem to be of great importance. So far as color and consequently the flavor of the drippings were concerned the area of the pan and its shape were important, the pan with the smaller area giving the lighter-colored drippings.

If the whole amount of drippings was used for gravy the darkening, if not excessive, might not be undesirable, but because of the number of uses for the excessive fat in drippings it is desirable to avoid the darkening of them. Moreover, authority can be found for the idea that this darkening means that the fat was heated to such a temperature as to render it less digestible.

The results obtained with different sized pans were not definite as regards the losses in weight in cooking. In comparing open and closed pans it was found that the total losses in weight in roasting were greater in the open pan. However, when cooked in a closed pan the meat was inferior in flavor and was not as attractive in appearance, since it did not brown well, nor was the color satisfactory if browned outside the pan and subsequently cooked. The meat cooked to a greater degree in the closed pan in fifteen minutes than in the open pan. When cooked in a closed pan a larger percentage of the material lost was recovered in the drippings, owing to the fact that in the open pan the drippings are almost water free, while in the closed pan considerable water is retained.

One of the points especially considered in these experiments was the total loss in weight in cooking and its relation to the cost of raw and cooked meat. Summarizing the results of 21 tests, the total meat before roasting weighed 62 pounds and after cooking 52.25 pounds, the loss being about one-sixth of the original weight. The average cost of the cooked meat was 19.2 cents per pound, "an increase of 4 cents a pound over the original cost." The possibility of using drippings, the loss of weight in boning, and some other problems were also considered.

BITTER MILK.[a]

Abnormal flavors in milk and milk products may be due to a number of causes. It is well known that certain weeds eaten by cows impart a characteristic flavor to the milk. Garlic or wild onion is a very noticeable example. The Alabama Station succeeded in removing the taste of bitterweed from cream (but not from milk) by mixing the cream with two or more times its volume of warm water and then separating again with a centrifugal separator. Proper attention to the feeding of cows will, of course, prevent trouble of this kind.

In 1890 H. W. Conn, of the Connecticut Storrs Experiment Station, isolated a species of bacteria from a sample of bitter cream and showed experimentally that the organism was the cause of the trouble. Several other investigators have also shown that bacteria may be the cause of bitterness in milk. A recent bulletin of the Ontario Agricultural College and Experimental Farm, by F. C. Harrison, publishes some interesting observations on bitter milk. In this case, however, the bitter flavor was caused by a form of yeast rather than by bacteria. Numerous cheese factories in Ontario were annoyed by the development of a bitter flavor in milk and curd. From a sample of such curd a yeast-like micro-organism designated *Torula amara*, or bitter torula, was isolated. This yeast, when separated from all other micro-organisms and added to milk which had been rendered sterile by heat, produced the characteristic bitter flavor. Cultures of the torula were added to milk, and the cheese and butter manufactured from it also possessed the bitter taste. In the investigations at one factory the torula was not found in milk drawn into sterile dishes nor in the air of the stable, but was found regularly in mixed milk, cheese, whey, can washings, and also on the leaves of certain trees under which milk cans were habitually kept.

In preventing such troubles as bitter milk, proper care of the milk is essential. Milk cans and all other utensils should be thoroughly washed and sterilized by heat, the milking should be done under the most favorable conditions for lessening contamination, the milk should be cooled promptly, and guarded as carefully as possible from all known sources of infection. A Farmers' Bulletin[b] of this Department contains suggestions for the care and handling of milk which, if followed, may be expected to lessen or prevent such troubles as arise from the growth of undesirable forms of micro-organisms in milk.

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[a] Compiled from Alabama Col. Bul. 121; Connecticut Storrs Rpt. 1890, p. 158; Ontario Agr. Col. and Expt. Farm Bul. 120.

[b] U. S. Dept. Agr., Farmers' Bul. 63.

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